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ATS TECHNICAL MEMORANDUM

NO. 3

EARLY SEASON WHEAT AREA ESTIMATION:
RESULTS AND A RECOMMENDED APPROACH

FOR USDA LACIE STAFF

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREIGN AGRICULTURAL SERVICE

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ABSTRACT

This technical memorandum addresses the problem of obtaining an early season wheat area estimate. The results of obtaining early season estimates for several sample segments are presented. An approach for making these estimates using current analyst procedures will be discussed.

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SECTION 1.0 INTRODUCTION

1.1 Purpose

The purpose of this technical memorandum is 1) to compare early season wheat area estimates (seeded wheat) to the best wheat area estimates obtained during the crop year and 2) to present an early season area estimate approach using current LACIE analyst procedures.

1.2 Situation

The users of an Application Test System (ATS), which evolved from LACIE technology and testing, have expressed the need for an early season area estimate and the importance that this estimate plays in management and economic decisions. An early season area estimate is defined as an area estimate of wheat within a scene that is obtained prior to Landsat detectable emergence of all the wheat grown within that scene.

Current procedures allow the analyst to classify only detectable wheat; i.e., wheat that has sufficient biomass to be detected and recorded by the Landsat scanner and visually observable by the analyst. This procedural constraint does not allow partially emerged wheat fields or fields that have a high probability of having been seeded to wheat to be included into an area estimate generated early in the growing season. Therefore, these estimates have been, and will continue to be biased low and are not a good indicator of wheat area.

SECTION 2.0 EARLY SEASON WHEAT AREA ESTIMATES USING LACIE CAPABILITIES

2.1 Application

During the I-100 effort of Phase III, an early season wheat area estimate was made on ten Canadian blind sites, one Canadian ITS, three United States ITS's, and three USSR segments. The analyst used Procedure-1¹ and the General Electric Image 100 interactive computer system to train and classify a seedbed prepared or otherwise tilled soil within the segments. A majority of these estimates were made from acquisitions acquired the first week of May 1977, which included any continuously cropped fields in the scene. A few estimates were made from acquisitions acquired the fall of 1976. In some segments the till soil field patterns were exactly alike in both the fall and spring acquisitions.

2.2 Results

These same segments were analyzed using Procedure-1 and I-100 capabilities to obtain wheat area estimates throughout the growing season. A comparison was then made between the best season estimate and the early season estimate. The results are summarized in Table 1. The mean difference between all segments was 1.8. Ground truth will become available for all segments in Table 1 except the USSR segments. To date, ground truth is available for three segments.

¹Processing procedures developed as a solution to the problems encountered during LACIE Phase I and Phase II. Details on these procedures are discussed in the Phase III CAMS Detailed Analysis Procedures, LACIE-00720, JSC-11693, August 1977.

TABLE 1. COMPARISONS BETWEEN EARLY SEASON WHEAT AREA ESTIMATE
AND THE BEST ESTIMATE MADE LATER IN THE GROWING SEASON

| LOCATION | EARLY SEASON WHEAT AREA ESTIMATE | WHEAT AREA ESTIMATE DURING GROWING SEASON | Δ |
|-------------|--|---|-------------------|
| CANADIAN BS | 14.3 | 14.7 | +0.4 |
| CANADIAN BS | 21.1 | 24.8 | +3.7 |
| CANADIAN BS | 32.3 | 32.3 | -0.0 |
| CANADIAN BS | 22.2 | 17.2 | -5.0 |
| CANADIAN BS | 19.4 | 20.1 | +0.7 |
| CANADIAN BS | 29.2 | 22.8 | -6.4 |
| CANADIAN BS | 32.8 | 30.7 | +2.1 |
| CANADIAN BS | 30.4 | 33.0 | +2.6 |
| CANADIAN BS | 25.7 | 21.7 | -4.0 |
| CANADIAN BS | 30.0 | 26.4 | -3.6 |
| CANADIAN BS | 41.4 | 34.8 | -6.6 |
| U.S. ITS | 37.0 | 35.2 | -1.8 |
| U.S. ITS | 6.6 | 7.0 | +0.4 |
| U.S. ITS | 35.4 | 30.0 | -5.4 |
| USSR SS | 25.5 | 29.7 | +4.2 |
| USSR SS | 45.4 | 41.8 | -3.6 |
| USSR SS | 15.5 | 10.8 | -4.7 |
| | $\bar{x}=27.3$ | $\bar{x}=25.5$ | $\bar{x}diff=1.8$ |

SECTION 3.0 AN APPROACH FOR EARLY SEASON WHEAT AREA ESTIMATES

3.1 Situation

Full utilization of trained analysts, currently available analyst tools, and system capabilities could improve estimates produced early in the growing season. Without extensive research and development, it is impossible to develop an early season estimate that can be universally applied to all sample segments, all countries. But the authors contend that with some modifications to current procedures, an early season estimate can be obtained for a majority of sample segments.

3.2 Assumptions

In developing an early season approach, the following assumptions must be accepted:

- 3.2.1 In most cases, seedbed preparation has to occur or significant soil disturbance occurs at or before the time the wheat seed is placed in the ground.
- 3.2.2 A trained analyst can detect bare soil within Landsat imagery and can also detect a spectral difference between relatively freshly tilled soil and soil that has not been tilled for a long period of time.
- 3.2.3 When there is partially emerged wheat (mottled signatures) within a field's boundaries, there is a high probability that the entire field is planted to wheat.

3.3 Approach

To obtain an early season estimate for a sample segment, its historical Landsat imagery and historical area estimates must be studied. Additional information on a segment is available from several sources within the system. For example, agrophysical units (APU) contain information on wheat area, crops that may be confused with wheat, cropping practices, and other pertinent agricultural data. Agrophysical units, areas having relatively similar physical conditions, currently exist for the U.S. Great Plains, USSR, and Canada and will be developed for other countries. Another example of helpful ancillary data is shown in Figure 1. The thousands of acres of wheat planted on fallow (upper number) and annually cropped (lower number) are given for most counties within the Great Plains. This information is extremely valuable because the analyst knows the county in which a segment is located. By assimilating these types of data, an analyst will have a good knowledge of the situation in the segment before he receives the first acquisition of the current crop year.

Figure 2 illustrates the type of estimates that could be obtained using the proposed approach and also the Phase III procedure. Plus signs (+) indicate the estimates made with the proposed approach, which utilizes all available information and system capabilities. The trend that occurs during the growing season is depicted. Dots (.) represent those estimates obtained using current techniques.

Using the proposed approach, an estimate is made for potential planted wheat. This estimate could be obtained prior to wheat

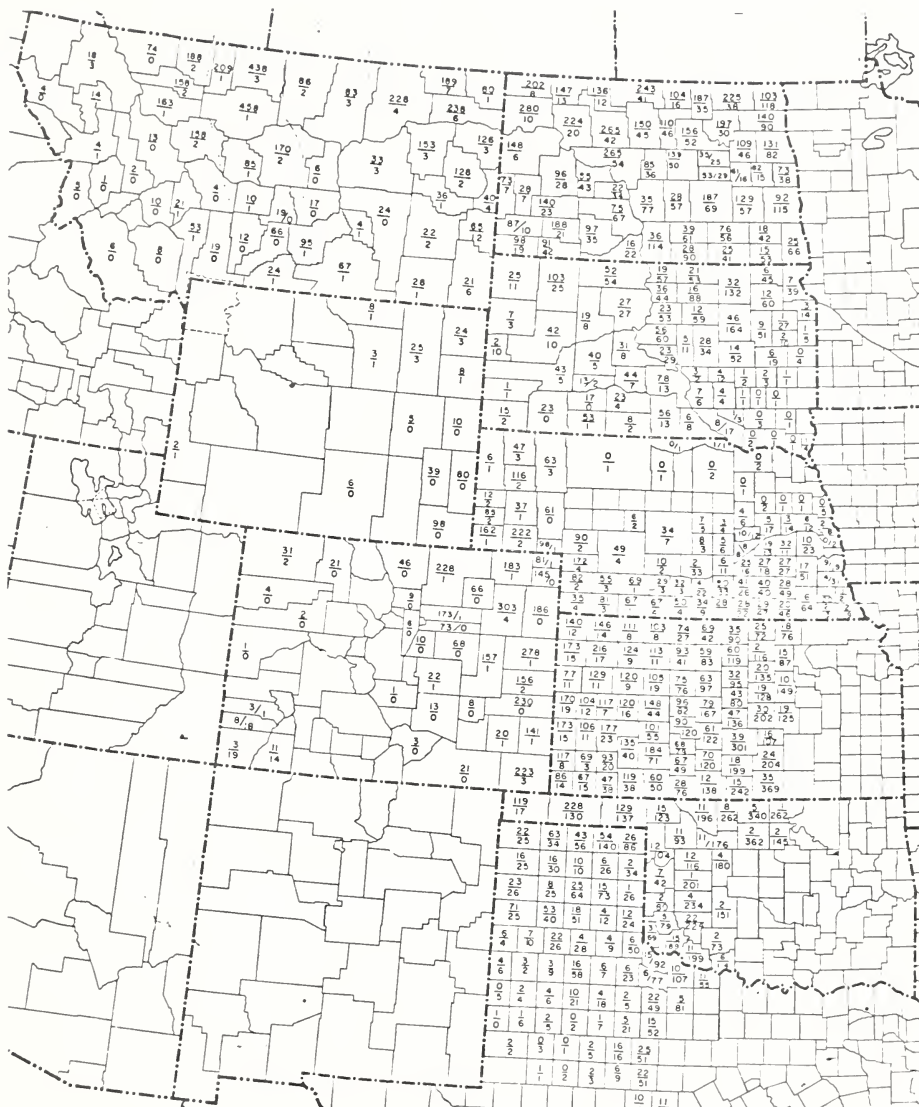


FIGURE 1. SUMMER FALLOW ACREAGE IN THE GREAT PLAINS

NOTE: Taken from Agricultural Research Service, April 1974, Summer Fallow in the Western United States, Research Report No. 17.

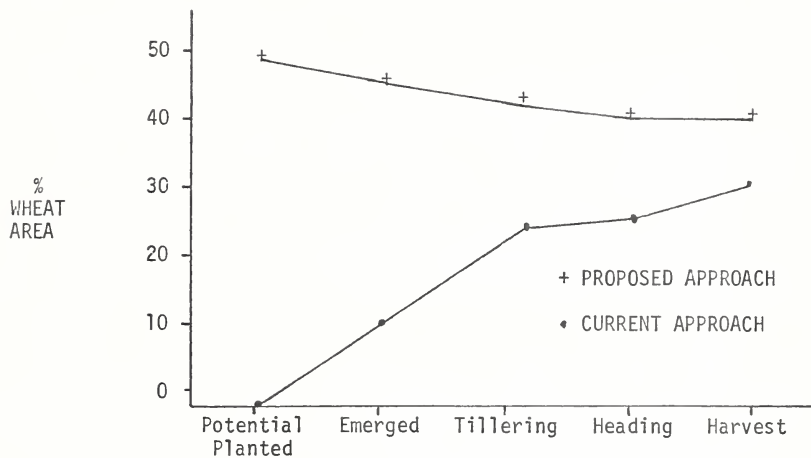


FIGURE 2. GRAPHIC ILLUSTRATION OF THE ESTIMATES THAT CAN BE OBTAINED FOR A SEGMENT USING THE PROPOSED APPROACH AND PHASE III TECHNIQUE

emergence and would represent an area estimate for prepared seedbeds. Currently such an estimate is not provided due to constraints placed on analyst procedures.

A new estimate will be made when an acquisition is acquired during or after wheat emergence. The crucial element in the proposed approach is the capability to obtain estimates for partially emerged fields. Procedures must allow the analyst to include the entire field in the estimate even though wheat is detectable in only a portion of that field.

Current procedures allow the analyst to obtain acceptable estimates at or after tillering or jointing growth stages. At this point in the growing season, the need for an early season estimate has diminished.

In summary, the proposed approach provides for an early season area estimate which does not currently exist. The estimates obtained using the proposed approach will be biased high but should be closer to the "at harvest" estimates than the current estimates that are biased low. Finally, the new approach will produce an early season estimate that indicates the maximum wheat area for a given segment.

SECTION 4.0 CONCLUSIONS



- 4.1 For the 17 segments analyzed in this study, there was no significant difference between the early season estimates and the best estimates made during the growing season.
- 4.2 An early season wheat area estimate can be obtained for a number of sample segments.
- 4.3 Current procedures can be utilized to obtain this estimate if:
 - 4.3.1 The analysts are allowed to process acquisitions obtained prior to wheat emergence.
 - 4.3.2 The analysts are allowed to include partially emerged wheat fields in the wheat area estimate.
 - 4.3.3 The analysts utilize historical Landsat imagery and other data for the purpose of making an early season estimate.
 - 4.3.4 The analyst fully utilizes spectral aids.



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